CLAIMS

What is claimed is:

1. Apparatus comprising:

first and second bit streams; and

an insertion circuit for combining the first and second bit streams into a time division multiplexed (TDM) output bit stream, the first bit stream being a TDM input bit stream, the TDM input and output bit streams being divisible into frames, each frame including plural channels, the second bit stream being an unframed stream of bit sequential data (BSD), wherein the insertion circuit is adapted to insert bits from the second bit stream into at least one channel of the first bit stream; and

a control interleaver for interleaving control information with the BSD wherein the control information includes bandwidth allocation information between the TDM input and the BSD.

2. The apparatus of Claim 1 wherein the control interleaver is adapted to interleave the control information into at least one channel of the TDM input bit stream that is designated for carrying BSD only.

3. The apparatus of Claim 1 wherein the insertion circuit is adapted to insert bits from the second bit stream into at least one channel of the TDM input bit stream that is designated for carrying either TDM data or BSD depending on a usage state of the channel.

4. The apparatus of Claim 3 further comprising an idle channel detector for detecting the usage state of channels of the TDM input bit stream from

examination of a channel associated signaling stream corresponding to the TDM input bit stream.

5. The apparatus of Claim 4 wherein for a detected usage state of IDLE for a TDM input stream channel, the insertion circuit inserts bits from the second bit stream, and wherein for a detected usage state of ACTIVE for a TDM input stream channel, the insertion circuit inserts no bits from the second bit stream.

6. The apparatus of Claim 1 further comprising a multiplexer for multiplexing at least one primary BSD bit stream and at least one auxiliary BSD bit stream to provide the second bit stream.

7. The apparatus of Claim 6 wherein the primary BSD bit stream comprises real time packet data and the auxiliary BSD bit stream comprises non-real time packet data.

8. The apparatus of Claim 6 wherein the multiplexer is adapted to select between the primary BSD bit stream and the auxiliary BSD bit stream based on a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD bit streams.

9. The apparatus of Claim 8 further comprising a throttle circuit for adjusting the modulus value based on an input rate associated with the primary BSD bit stream.

10. The apparatus of Claim 9 further comprising a primary bit queue for holding bits of the primary BSD bit stream wherein the throttle circuit monitors depth of the primary bit queue and adjusts the modulus value based upon rate of change in the depth and a projected time to empty the primary bit queue.

11. The apparatus of Claim 6 wherein the auxiliary BSD bit stream includes control information interleaved with BSD.

12. The apparatus of Claim 11 further comprising a hardware control link protocol (HCLP) insertion circuit for inserting the control information in HCLP commands.

13. The apparatus of Claim 12 wherein the insertion circuit inserts the HCLP commands into a channel of the TDM input bit stream designated for carrying BSD and control information.

14. The apparatus of Claim 11 wherein the control information includes a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD bit streams.

15. The apparatus of Claim 11 wherein the control information includes usage state information corresponding to channels of the TDM input bit stream.

16. The apparatus of Claim 11 wherein the control information is repeated at least once to permit error detection at a far end device.

17. The apparatus of Claim 11 wherein the control information is repeated at least twice to permit error correction at a far end device.

18. The apparatus of Claim 1 further comprising a signaling insertion circuit for inserting signaling information from a channel associated signaling stream into corresponding channels of the TDM input bit stream.

19. The apparatus of Claim 18 further comprising a control timing circuit for establishing a signal frame interval (SFI) comprising twenty-four frame intervals of the TDM input bit stream.

20. The apparatus of Claim 19 further comprising a hardware control link protocol (HCLP) insertion circuit for inserting an HCLP command into a designated control channel, the HCLP command indicating start of the SFI.

21. The apparatus of Claim 20 wherein the signaling information includes ABCD signaling bits, the signaling insertion circuit adapted to insert the A bit into the corresponding channel in the sixth frame of the SFI, the B bit into the corresponding channel of the twelfth frame of the SFI, the C bit into the corresponding channel of the eighteenth frame of the SFI, and the D bit into the corresponding channel of the twenty-fourth frame of the SFI frame.

22. The apparatus of Claim 1 further comprising a transmission loop and a line interface unit for coupling the TDM output bit stream to the transmission loop.

23. The apparatus of Claim 22 wherein the transmission loop is a T1 carrier.

24. The apparatus of Claim 22 wherein the transmission loop is an E1 carrier.

25. The apparatus of Claim 22 wherein the transmission loop is a digital subscriber line.

26. A method of communication comprising:

providing first and second bit streams; and

combining the first and second bit streams into a time division multiplexed (TDM) output bit stream, the first bit stream being a TDM input bit stream, the TDM input and output bit streams being divisible into frames, each frame including plural channels, the second bit stream being an unframed stream of bit sequential data (BSD), wherein combining includes inserting bits from the second bit stream into at least one channel of the first bit stream and interleaving control information with the BSD wherein the control information includes bandwidth allocation information between the TDM input and the BSD.

27. The method of Claim 26 wherein interleaving includes interleaving the control information into at least one channel of the TDM input bit stream that is designated for carrying BSD only.

28. The method of Claim 26 wherein inserting includes inserting bits from the second bit stream into at least one channel of the TDM input bit stream that is designated for carrying either TDM data or BSD depending on a usage state of the channel.

29. The method of Claim 28 further comprising detecting the usage state of channels of the TDM input bit stream by examining a channel associated signaling stream corresponding to the TDM input bit stream.

30. The method of Claim 26 further comprising multiplexing at least one primary BSD bit stream and at least one auxiliary BSD bit stream to provide the second bit stream.

31. The method of Claim 30 wherein the primary BSD bit stream comprises real time packet data and the auxiliary BSD bit stream comprises non-real time packet data.

32. The method of Claim 30 wherein multiplexing includes selecting between the primary BSD bit stream and the auxiliary BSD bit stream based on a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD bit streams.

33. The method of Claim 32 further comprising adjusting the modulus value based on an input rate associated with the primary BSD bit stream.

34. The method of Claim 33 further comprising holding bits of the primary BSD bit stream in a primary bit queue and wherein adjusting includes adjusting the modulus value based upon rate of change in the depth of the primary bit queue and a projected time to empty the primary bit queue.

35. The method of Claim 30 further including interleaving control information with auxiliary BSD in a control channel.

36. The method of Claim 35 wherein the control information includes a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD bit streams.

37. The method of Claim 35 wherein the control information includes usage state information corresponding to channels of the TDM input bit stream.

38. The method of Claim 35 wherein interleaving includes repeating the control information at least once to permit error detection at a far end device.

39. The method of Claim 35 wherein interleaving includes repeating the control information at least twice to permit error correction at a far end device.

40. The method of Claim 26 further comprising inserting signaling information from a channel associated signaling stream into corresponding channels of the TDM input bit stream.

41. The method of Claim 40 further comprising establishing a signal frame interval (SFI) comprising twenty-four frame intervals of the TDM input bit stream and wherein inserting signaling information includes inserting ABCD signaling bits, with the A bit inserted into the corresponding channel in the sixth frame of the SFI, the B bit inserted into the corresponding channel of the twelfth frame of the SFI, the C bit inserted into the corresponding channel of the eighteenth frame of the SFI, and the D bit inserted into the corresponding channel of the twenty-fourth frame of the SFI frame.

42. The method of Claim 26 further comprising cascading the TDM output stream with a second BSD bit stream to provide a second TDM output stream.

43. The method of Claim 42 further comprising multiplexing a primary BSD bit stream and an auxiliary BSD bit stream to provide the second BSD bit stream.

44. Apparatus comprising:

a time division multiplexed (TDM) input stream divisible into frames, each frame having plural channels including channels designated for carrying either TDM data or bit sequential data (BSD) depending on usage state information of the channels; and

an inverse multiplexer for separating data in the BSD channels into a primary BSD output bit stream and an auxiliary BSD output bit stream based on

the usage state information and a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD streams.

45. The apparatus of Claim 44 further comprising a control channel detector for examining a control channel in the TDM input stream to determine the usage state information and modulus value.

46. The apparatus of Claim 44 further comprising an idle code insertion circuit for inserting idle code into TDM channels designated IDLE in the usage state information to provide a TDM output stream.

47. The apparatus of Claim 44 wherein the primary BSD bit stream comprises real time packet data and the auxiliary BSD bit stream comprises non-real time packet data.

48. A method of communication comprising:

receiving a time division multiplexed (TDM) input stream divisible into frames, each frame having plural channels including channels designated for carrying either TDM data or bit sequential data (BSD) depending on usage state information of the channels; and

separating data in the BSD channels into a primary BSD output bit stream and an auxiliary BSD output bit stream based on the usage state information and a modulus value indicating an allocation of available BSD bandwidth between the primary and auxiliary BSD streams.

49. The method of Claim 48 further comprising examining a control channel in the TDM input stream to determine the usage state information and modulus value.

50. The method of Claim 48 further comprising inserting idle code into TDM channels designated IDLE in the usage state information to provide a TDM output stream.

51. The method of Claim 48 wherein the primary BSD bit stream comprises real time packet data and the auxiliary BSD bit stream comprises non-real time packet data.

52. A method of dynamically controlling bandwidth associated with real time and non-real time data on a transmission loop, the method comprising:

providing a first channel carrying real time data;

providing a second channel carrying non-real time data; and

controlling the throughput of the first or second channel by matching the real time data input to the loop transmission rate via a control channel.

53. The method of Claim 52 further comprising providing a third channel carrying TDM data and wherein controlling includes recovering idle bandwidth of the third channel to provide at least a portion of the first and second channels.

54. A method of communication comprising:

multiplexing primary and auxiliary bit sequential data (BSD) streams to provide an unframed BSD bit stream;

combining the unframed BSD bit stream with a time division multiplexed (TDM) input bit stream to provide a TDM output bit stream, the TDM output bit stream divisible into frames, each frame having plural channels including channels designated for carrying either TDM data or BSD depending on usage state information of the channels;

interleaving control information with the BSD wherein the control information includes the usage state information and a modulus value indicating

an allocation of available BSD bandwidth between the primary and auxiliary BSD streams;

transmitting the TDM output bit stream to a receive end;

receiving the TDM output stream at the receive end; and

separating data in the BSD channels into a primary BSD output bit stream and an auxiliary BSD output bit stream based on the usage state information and the modulus value indicating the allocation of available BSD bandwidth between the primary and auxiliary BSD streams.